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Signed Andrew Gersey

Dated 7 February 2003

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
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1. Your reference — NS/JT/01457GB

2. Patent application number *(The Patent Office will fill in this part)* — 28 DEC 2001 | 0131059.8

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

(1) MICHAEL HENEIN
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Morgans Walk,
Battersea,
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(2) ASHRAF KHIR,
153, Spencer Road,
Osterley,
Middlesex TW7 4BW

Patents ADP number *(if you know it)*

08296139001 08296147001

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention — "Intravascular Pump"

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

BROOKES BATCHELLOR
102-108 Clerkenwell Road,
London EC1M 5SA

Patents ADP number *(if you know it)* — 08142291001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

No

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	3
Claim(s)	1
Abstract	1
Drawing(s)	4 + 4 SV

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Brookes Batchellor Date 28/12/07

Brookes Batchellor

12. Name and daytime telephone number of person to contact in the United Kingdom Mr. N. Shindler 010 7253 1563

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Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.*

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"Intravascular Pump"

This invention relates to heart pumps, and in particular, to an intravascular pump which can be used to assist the operation of a patient's heart, when it is in a weak condition.

Various types of intravascular heart pumps are known, but these generally require major surgery, to enable them to be suitably located in an appropriate position in the heart. The present invention seeks to introduce a heart pump which is capable of providing significant assistance to the heart, whilst reducing the degree of invasive surgery required to introduce it into the operative position.

The present invention provides an intravascular bi-directional pump which is adapted to be located in the upper aorta, whereby it can assist the left ventricle to eject in the forward direction during systole, so as to off-load the heart, and also pump an adequate amount in the reverse direction, during diastole to secure coronary flow.

Preferably, the pump is placed either in the ascending aorta, just distal to the aortic valve leaflets, or in the upper descending aorta.

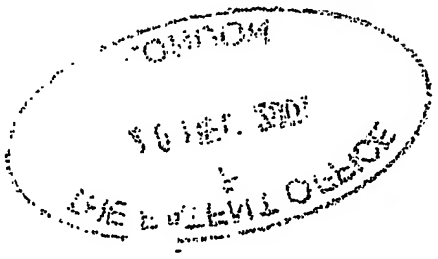
Preferably the pump is mounted (hung) into a stent that can be deployed by means of a balloon. The latter can be withdrawn after the stent has been established in situ. Both the stent and the pump attached to it will then remain inside the aorta.

The pump may be inserted by either

1. Surgically slitting the aorta at the preferred position (see above) and placing the pump.

2. Inserting the pump subcutaneously from the groin or lower abdomen, and advancing it into the aorta until it reaches the preferred position.

Various type of pumps may be utilised to provide the functions required, such as centrifugal, positive displacement or axial.



The pump may be powered by a direct connection, such as a wire running through the aortic wall and the skin, and connected to an outside battery, or alternatively by means of a wireless connection, for example using induction coils.

Some embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic view of the heart, showing the upper aorta;

Figure 2 is a schematic view of a positive displacement pump;

Figure 3 is a schematic view of an axial pump;

Figure 4 is a schematic view of a first type of centrifugal pump, and

Figure 5 is a schematic view of a second type of centrifugal pump.

Referring firstly to Figure 1, the heart is illustrated diagrammatically at 2, and the ascending aorta is indicated at 4. A suitable type of heart pump (as described in more detail below) is inserted in the region 4, either by slitting the aorta at the preferred position, or by inserting the pump from the groin or lower abdomen, and advancing it along the aorta until it reaches the preferred position. Preferably, this is achieved using a known "angioplasty " type of technique. This involves mounting the pump in a stent and delivering it on a deflated balloon to the desired position, after which the balloon is withdrawn. Both the stent and the pump then remain inside the aorta.

Figure 2 illustrates a first possible type of pump that may be utilised for the invention, which is a simple cylindrical positive displacement pump, having a piston 6 and flow outlets 8 and 10 at either end. By means of suitable switchable one way valves, for example in the piston, the pump can be arranged to move fluids in either direction.

Similarly, Figure 3 illustrates an axial pump, having a screw type rotor 12, so that the direction of pumping can be reversed, by reversing the direction of rotation of the rotor.

In the case of the Figure 2 or Figure 3 pumps, the direction of pumping will be reversed, so that a calculated amount is caused to flow forward towards the periphery, and backwards towards the heart in systole and diastole respectively.

Figure 4 illustrates an alternative type of centrifugal pump, having a rotary impeller 14 mounted in the casing 16, so that the inlet region 18 is at the axis of the impeller, whilst the outlet 20 is at the circumference. In a pump arrangement of this kind, if a pair of impellers are arranged to rotate about the same axis 30, as illustrated diagrammatically in the view of Figure 5, the pump can be made to operate bi-directionally, depending upon which of the rotors 26 or 28 is driven at any given time. Thus if the rotor 26 is driven, whilst the rotor 28 is left stationary, fluid will be drawn into the inlet 24, past the stationary vanes of the rotor 28, and axially into the central region of the driven rotor 26 so that aperture 22 becomes an outlet. In a similar way, if the rotor 28 is driven, the aperture 22 becomes an inlet, whilst the aperture 24 becomes an outlet.

Alternatively, by adding a suitably oriented additional inlet/outlet duct to the simple centrifugal pump casing of Figure 16, and closing off the axial inlet, the flow can be reversed simply by reversing the direction of rotation of the fan blades, provided that they are also suitably oriented.

The pump can be powered either by:

1. Wireless power transmission, where the required power needed is transferred to the rotor wirelessly from outside the body by means of coils placed on the skin, or

2. Using a wire that runs through the aortic wall and the skin to be connected to an outside-the-body battery that can be charged/replaced or disconnected.

CLAIMS

1. An intravascular bi-directional pump which is adapted to be located in the upper aorta, whereby it can assist the left ventricle to eject in the forward direction during systole, so as to off-load the heart, and also pump an adequate amount in the reverse direction, during diastole, to secure coronary flow.

2. An intravascular bi-directional pump according to claim 1 which is adapted to be placed either in the ascending aorta, just distal to the aortic valve leaflets, or in the upper descending aorta.

3. An intravascular bi-directional pump according to claim 1 or claim 2 which is adapted to be mounted into a stent.

4. An intravascular bi-directional pump according to any preceding claim in which the pump is a centrifugal pump, a positive displacement pump or an axial flow pump.

5. A method of assisting coronary flow comprising placing a bi-directional pump in the ascending aorta, just distal to the aortic valve leaflets, or in the descending aorta.

6. A method according to claim 5 in which the pump is inserted from the groin or the lower abdomen, and advanced into the aorta until it reaches the required position.

7. An intravascular bi-directional pump substantially as herein described with reference to any one of Figures 2, 3, 4 or 5 of the accompanying drawings.

ABSTRACT

"Intravascular Pump"

An intravascular bi-directional pump is disclosed which is adapted to be located in the upper aorta, whereby it can assist the left ventricle to eject in the forward direction during systole, so as to off-load the heart, and also pump an adequate amount in the reverse direction, during diastole, to secure coronary flow.

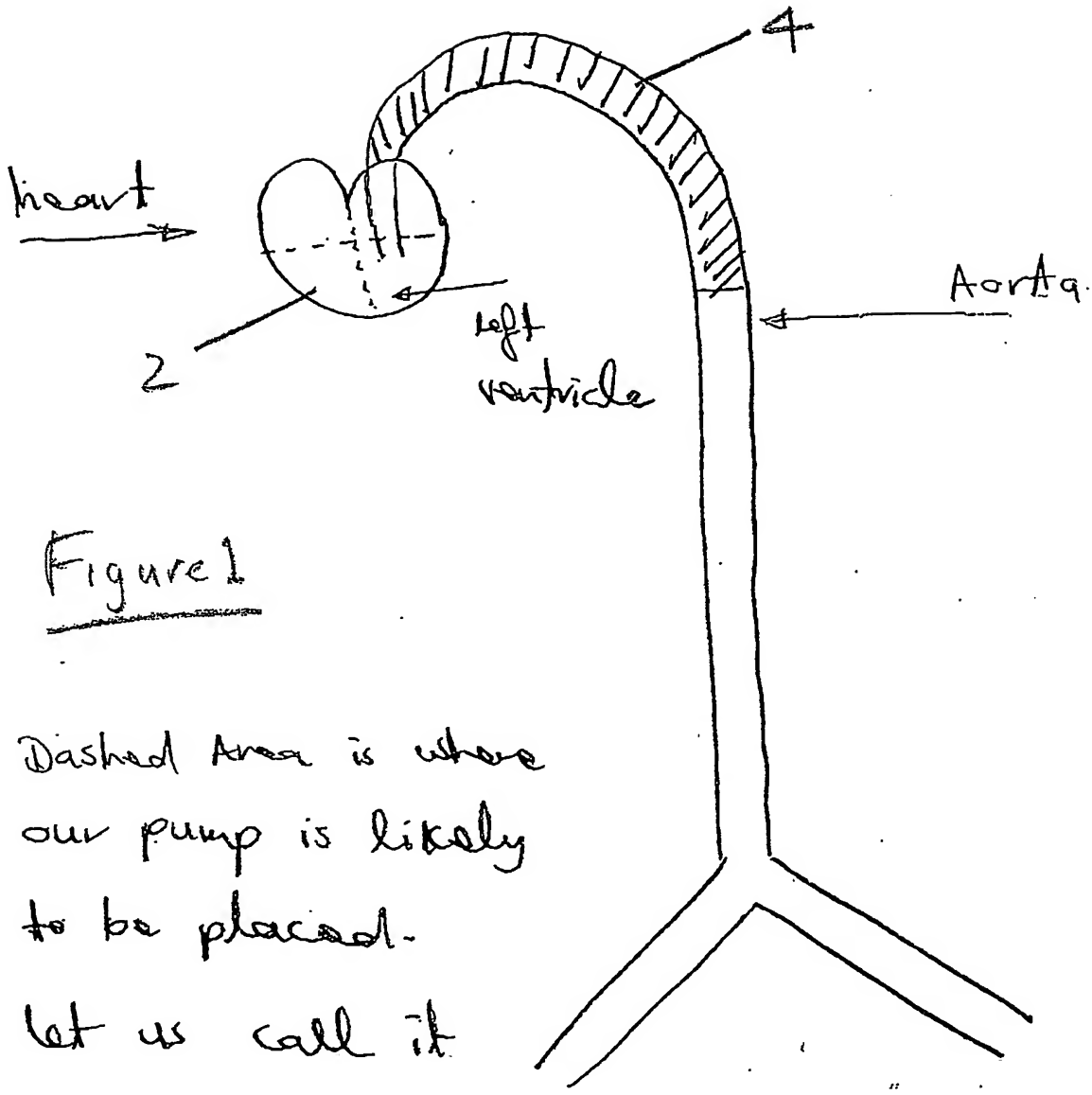


Figure 1

Dashed Area is where our pump is likely to be placed.

let us call it "upper Aorta"

(2)

positive Displacement Pump

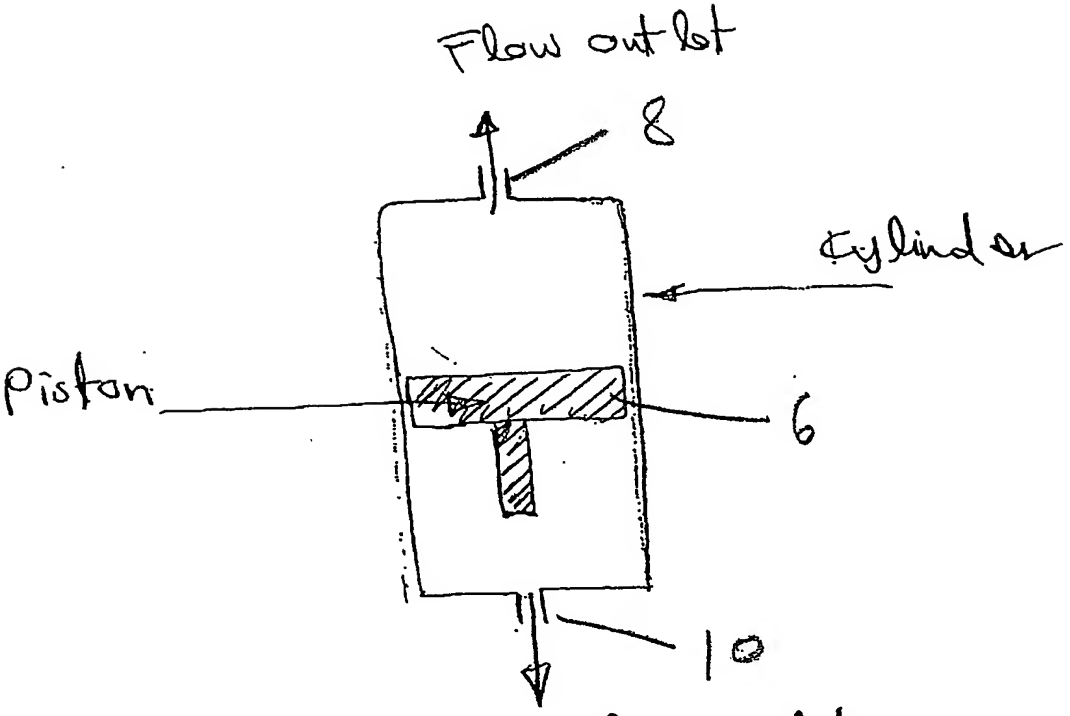


Figure 2

the Piston pumps in two directions (not simultaneously) at different times.

(3)

Axial Pump

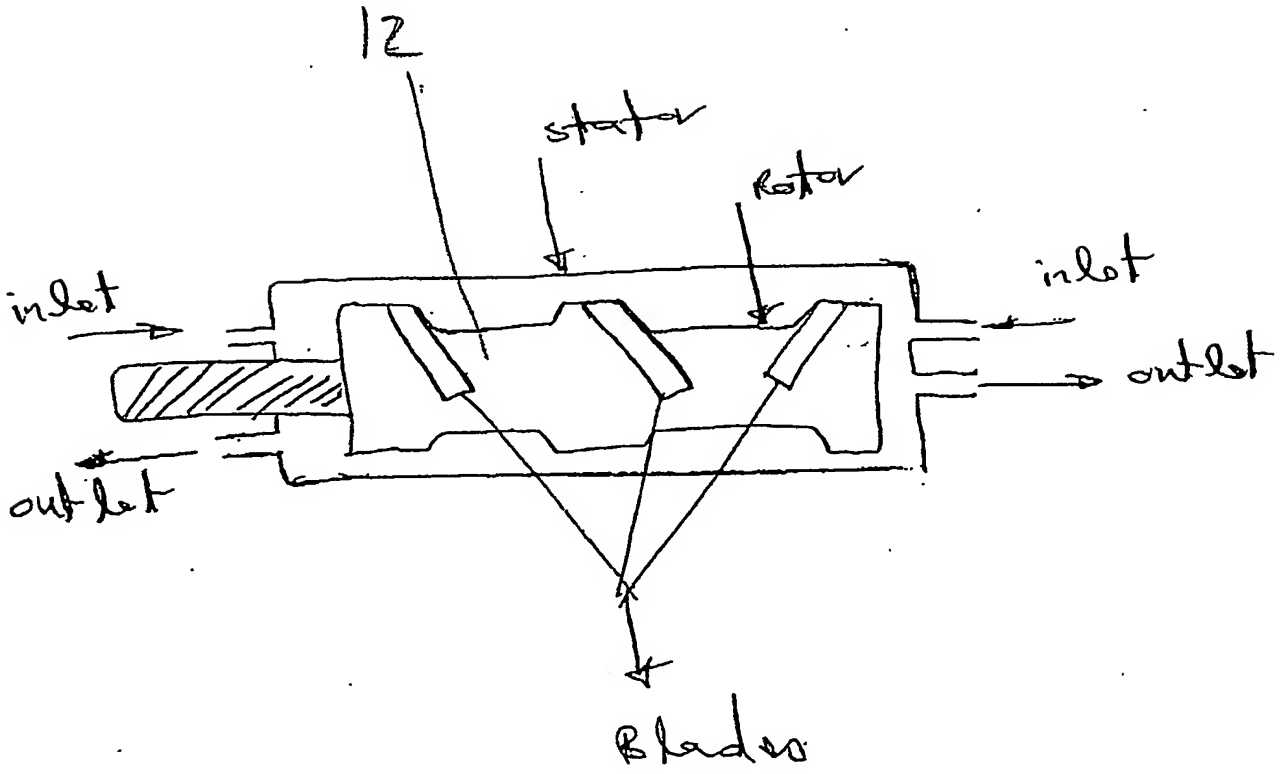


Figure 3

(4)

Centrifugal Pump

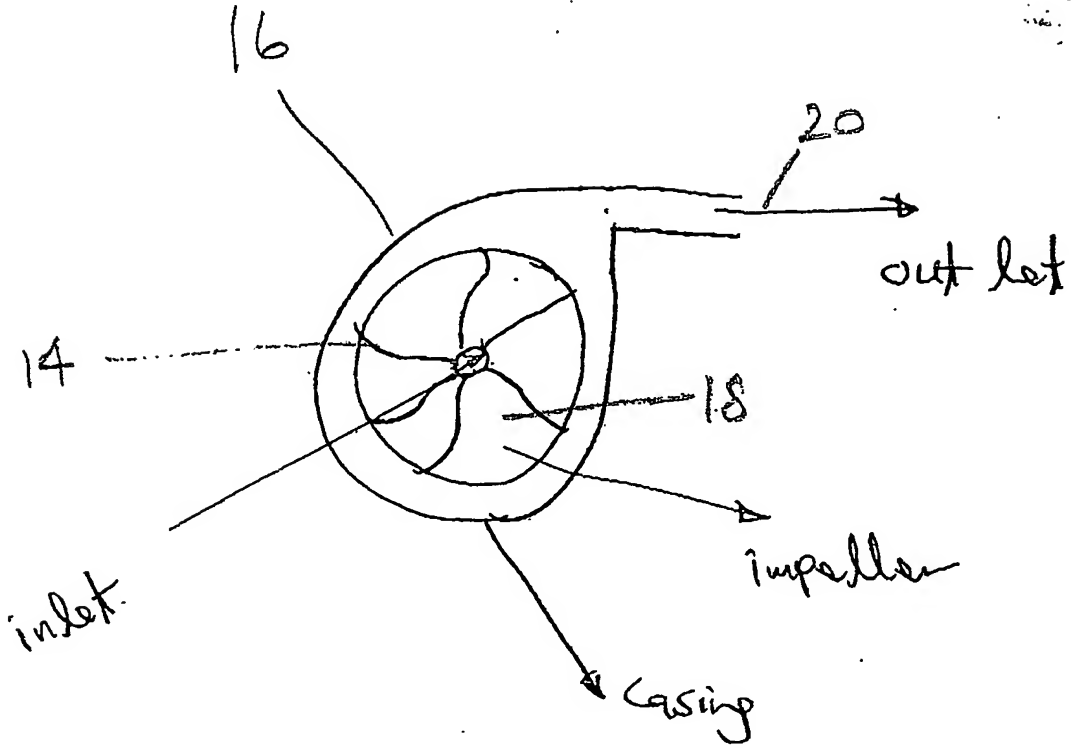


Figure 4

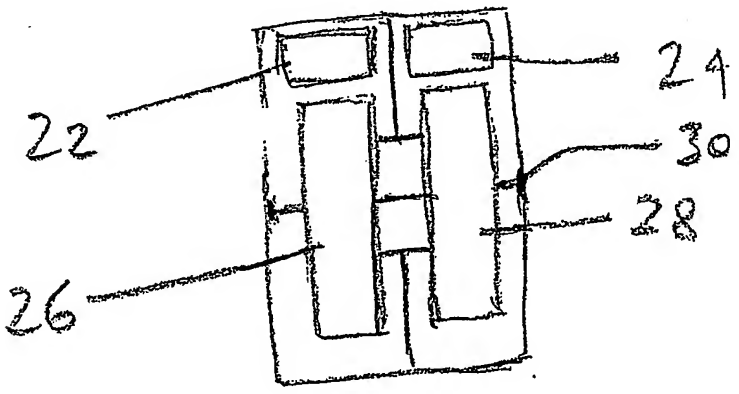


Figure 5